

Code 930 • <http://esdcd.gsfc.nasa.gov>**Earth and Space Data Computing Division**

Earth Sciences Directorate, Goddard Space Flight Center

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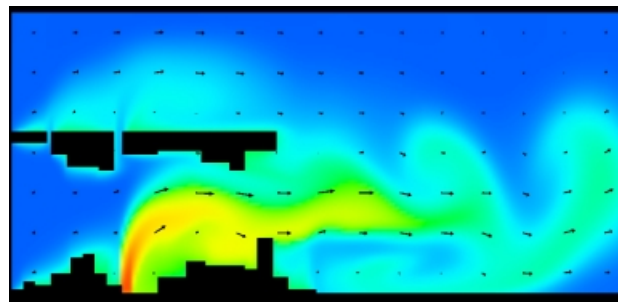
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**Computational  
Technologies Project****Earth System Modeling Framework  
Team Introduces Version 1.0**

Three software development teams recently introduced Earth System Modeling Framework (ESMF) Version 1.0, a key NASA contribution to the President's \$4.5 billion U.S. Climate Change Science Program. The National Center for Atmospheric Research (NCAR), the Massachusetts Institute of Technology (MIT), and GSFC lead the ESMF effort to allow weather and climate models from different researchers to operate together on parallel supercomputers, enabling comparison of alternative scientific approaches and ultimately improving predictive capabilities. A demonstration of the prototype ESMF was a highlight of the Second ESMF Community Meeting, held May 15, 2003, at Princeton University. The event drew an international audience of 120 climate modelers, software developers, and agency managers.

The ESMF is a national-scale collaboration involving NASA, the National Oceanic and Atmospheric



**The Second ESMF Community Meeting included a demonstration of a multi-component fluid flow application built using ESMF Version 1.0.** Image credits: Jon Wolfe and Nancy Collins, NCAR

Administration (NOAA), the National Science Foundation (NSF), the U.S. Department of Energy, and academia. Tsengdar Lee, information systems specialist and acting manager for the Global Modeling and Assimilation Program, NASA's Office of Earth Science (OES), gave the welcome talk. "The ESMF will provide the nation with an unprecedented framework that enables modeling the weather and climate system at multiple time and spatial scales and provides a seamless transition from research to operation environments," he said.

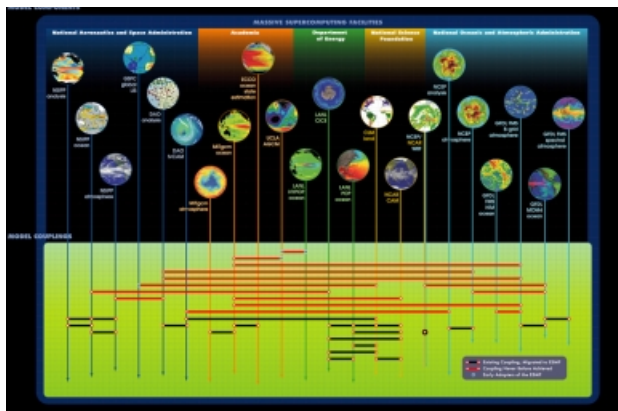
"The ESMF is not a research project," stressed Cecelia DeLuca, manager of the ESMF core implementation team at NCAR, an NSF center. "We want to support the community at the production level, by providing a reliable, portable, well-maintained, and well-supported software package." By the January 2005 software release, the goal is for any institution to be able to use the ESMF for coupling atmosphere, ocean, and land models as well as data assimilation systems.

ESMF Version 1.0 focuses on the "superstructure" for coupling models. It contains enough of the planned capabilities for completing the initial set of "interoperability experiments" later this year. These experiments will create three entirely new coupled climate modeling systems by, for the first time, pairing models from NOAA's Geophysical

Fluid Dynamics Laboratory (GFDL) and MIT, from NCAR and NOAA's National Centers for Environmental Prediction, and from the GSFC-based NASA Seasonal-to-Interannual Prediction Project and Data Assimilation Office (DAO), which have merged to form the Global Modeling and Assimilation Office (GMAO).

"High-resolution seasonal forecasting is one example of new science that could result by combining modeling techniques from the nation's leading climate research centers," said Venkatramani Balaji, chief ESMF developer at GFDL.

The first ESMF release also includes a basic version of the "infrastructure" that will offer utilities and data structures for creating model components. As Chris Hill, chief ESMF developer at MIT, explained, "the infrastructure layer will provide a standard software platform that can support a broad span of Earth science applications on a wide range of target hardware," streamlining the development of Earth system modeling components.



**A cross-section of the ESMF poster depicts 22 model components and ESMF-enabled connections.** Image credit: Laurie Graham, GST

A 24"x36" color poster about the ESMF and its potential impacts is available at no charge by emailing [jcohen@pop900.gsfc.nasa.gov](mailto:jcohen@pop900.gsfc.nasa.gov).

<http://ct.gsfc.nasa.gov>

<http://www.esmf.ucar.edu>

<http://www.usgcrp.gov>

## Supercomputer Serves Up Giant Mosaic of Milky Way Images

Using new software on a powerful supercomputer, researchers have created one of the largest science-grade mosaics of astronomical images to date. This giant mosaic contains 144 million pixels of information—the equivalent of nearly 200 computer screens. It encompasses enough of our Milky Way galaxy to help astronomers address such cosmic mysteries as star formation.

California Institute of Technology (Caltech) and Jet Propulsion Laboratory (JPL) scientists developed the Montage software to build mosaics sufficiently large for studying astronomical structures as complete entities. In a collaboration with San Diego Supercomputer Center (SDSC) at the University of California, San Diego, the team harnessed SDSC's IBM Blue Horizon supercomputer to seamlessly combine 1,041 images into a unified whole.

The mosaic was derived using images observed in three near-infrared bands by the ground-based telescopes of the Two Micron All Sky Survey (2MASS). In merging the images, Montage removed distorting effects from the atmosphere to yield a mosaic that preserves the scientific fidelity of the original observations.

"2MASS covers the entire sky and provides a census of our own galaxy at an unprecedented level of detail," said Bruce Berriman, Montage project manager at Caltech's Infrared Processing and Analysis Center. "Widely studied structures, such as regions of star formation, are so large that a single image taken by a telescope cannot include all the phenomena astronomers must investigate. Studies of small areas can give a misleading picture of the physics of such structures, so researchers need mosaics of these images."

The Montage software is a key component of the National Virtual Observatory (NVO), which, when complete, will supply access to several major astronomical data collections via the Web. These include 2MASS (10 trillion bytes or 10 TB of data) and the optical observations from the Digitized Palomar Observatory Sky Survey (2 TB of data) and the Sloan Digital Sky Survey (eventually 15 TB of data).

The 2MASS images reside in a mass storage system at SDSC, so Blue Horizon was the natural choice for assembling the mosaic. With images spread across 384 processors, the mosaic was processed in a mere 25 minutes.

Montage will eventually become available as an on-demand Web service, with the mosaics themselves processed on the TeraGrid. This is a nationwide net-



A portion of the 2MASS mosaic showing the “War and Peace Nebula.” Image credit: Montage Project

work of supercomputers and mass storage devices, including those at SDSC, that is sponsored by the NSF. Montage users will be able to order NVO mosaics according to specific parameters. By early 2005, the performance goal is to fulfill requests in a few minutes on average.

“We want to ensure that the TeraGrid has the data management and computational capabilities so that manipulation of a 10-TB sky survey is a reasonable task to attempt,” said Reagan Moore, Co-Program Manager for Data and Knowledge Systems at SDSC. “The NVO is focusing on the types of software infrastructure that are required to enable this sort of science. From the standpoint of NVO and TeraGrid, the 2MASS problem is an exemplary application for astronomy.”

Montage capabilities eventually will include combining astronomical images observed in multiple wavelengths, whether the near-infrared of 2MASS or the optical of the Palomar survey. “One of the most powerful probes of physics is the behavior of a structure at different wavelengths,” Berriman said. “Astronomers produce maps of a structure, but they cannot layer them on top of each other easily. Montage will ensure that astronomers can overlay images and study them as if they are part of the same image.”

Collaborators on the 2MASS mosaic were Tom Prince (principal investigator (PI)), Bruce Berriman (project manager), Anastasia Clower Laity, John

Good, Roy Williams, and Michael Feldmann of Caltech; Joseph Jacob, Daniel Katz, and Atilla Bergou of JPL; and Leesa Brieger, George Kremenek, and Reagan Moore of SDSC.

*(2MASS is funded by NASA and NSF. It is a joint project of the University of Massachusetts and Caltech’s Infrared Processing and Analysis Center. The 2MASS image mosaic products generated by Montage are not endorsed by the 2MASS project.)*

<http://ct.gsfc.nasa.gov>

<http://montage.ipac.caltech.edu>

## SVS

### “Multisensor Fire Observations” Featured by NASA, National Media

The Scientific Visualization Studio (SVS) has produced “Multisensor Fire Observations,” a 5-minute, narrated video for NASA’s Earth Observing System Data and Information System (EOSDIS). The video promotes the interdisciplinary data holdings managed by the EOSDIS Distributed Active Archive Centers (DAAC).

The video prompted the second-ever NASA Headquarters Earth Science Update (ESU) press conference, which took place on July 22, 2003. NOVA incorporated ESU content into a 90-second fire story for the “NOVA Minute” series that was fed to ABC affiliates and posted on the WGBH Web site during the replay of a 2-hour NOVA special on fire. Forty additional stories ran on national, cable, and local stations during the week of the ESU. Most notable were a short voiceover on the CBS Evening News, a segment run during CNN’s weekend science show, and an appearance on MSNBC as the #3 story in Keith Olbermann’s daily top 10 news stories program.

In addition, the video was accepted into the internationally recognized SIGGRAPH Computer Animation Festival, held July 27–31, 2003. The festival is a popular segment of the annual SIGGRAPH event, showcasing computer-generated animations using leading-edge technology and design from around the world.

Visualizing Moderate Resolution Imaging Spectroradiometer (MODIS) data, the video depicts fires around the globe from October 1, 2001, to September 30, 2002. The animation features three major U.S. fires: the Hayman Fire in Colorado, the Rodeo-Chediski Fire in Arizona, and the Biscuit Fire in Oregon. The visualized fires also incorporate data from the Multi-angle Imaging Spectro-Radiometer (MISR), Landsat 7 Enhanced Thematic Mapper Plus





**Global fire activity detected by MODIS on July 4, 2002, is displayed as tiny fire pixels. Each pixel depicts the occurrence of fire within a 1-km region, but may not correspond precisely to the fire's extent. As the fires age, the pixels change color from red to orange, yellow, and then gray as the fires burn out.**

Image credit: SVS

(ETM+), and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER).

The fire data appear on a rotating Earth overlaid with data sets of global phenomena to show their relationship to the fires. Data sets and multispectral imagery include cloud circulation patterns from Geostationary Operational Environmental Satellite (GOES), rainfall patterns from Tropical Rainfall Measuring Mission (TRMM), aerosol indices from Total Ozone Mapping Spectrometer (TOMS), land cover from MODIS and Landsat, topography from GTOPO30, human habitation from Gridded Population of the World (GPW), and near-surface wind patterns from SeaWinds.

For the true-color Earth background, the SVS used a version of GSFC's "Blue Marble" dataset, which is composited mostly from MODIS data.

The movie was directed by Horace Mitchell, SVS Manager, with Cynthia Starr of GST as the lead animator and other significant production support from SVS staff. The narration was written by Jarrett Cohen of GST and read by Goddard TV's Michael Starobin of HSTI.

<http://svs.gsfc.nasa.gov>

[http://www.nasa.gov/vision/earth/everydaylife/ESU\\_FIRES.html](http://www.nasa.gov/vision/earth/everydaylife/ESU_FIRES.html)

<http://nasadaacs.eos.nasa.gov/scienceoffire.html>

### **Artwork at SIGGRAPH**

The SIGGRAPH 2003 Art Gallery accepted 4 pieces of original digital artwork created by SVS colleagues. Gregory Shirah, a computer scientist and visualization expert, and Marte Newcombe, an artist with GST, collaborated on three of the pieces. The

work consists of NASA-derived data, mathematical shapes, and other imagery that were digitally transformed into the final pieces. One of Shirah's pieces was further honored by being selected by the 2003 SIGGRAPH Traveling Art Show, an exhibit that will be shown in art galleries worldwide for 2 years.

<http://www.siggraph.org/artdesign/gallery/S03/2d/0431.html>

<http://www.siggraph.org/artdesign/gallery/S03/2d/0089.html>

## **NCCS**

### **Preparing for Atmospheric Data Assimilation Research and Operations for the GMAO**

The large-scale, computationally intensive atmospheric data assimilation conducted by GSFC's Data Assimilation Office (DAO) is returning to the NCCS from the NASA Advanced Supercomputing (NAS) Division at NASA's Ames Research Center (ARC). Now part of GSFC's Global Modeling and Assimilation Office (GMAO), this group will have its computational and data storage requirements provided by the NCCS by the end of Fiscal Year 2003.

The NCCS has contracted with SGI to help migrate approximately 174 TB of GMAO data from ARC. The NCCS is working with CSC and their subcontractor Halcyon to manage the migrated data. Continuing work includes developing software based upon Storage Resource Broker with an Oracle database for metadata and providing other software services. The NCCS, through support contractor AMTI, has worked with the GMAO to port and integrate major codes to NCCS systems and to provide expanded support services for the increased workload.

SGI worked with the NCCS to split the NCCS' existing 512-processor SGI Origin 3800 into a 384-processor batch system and a 128-processor system. The 128-processor system will provide dedicated support to the GMAO operations work. The new configuration will improve input/output performance as well as allocate processors more efficiently. The NCCS has added two SGI Origin 300 systems to act as highly reliable file servers and added new high capacity tape drives and storage network capacity.

Parallel operations with the GMAO's GEOS-4 operational work performed both at the NCCS and NAS began in August to ensure a smooth transition of the workload to the NCCS.

### **Expanded NCCS Help Desk Coverage**

On August 1, the NCCS officially began expanded Help Desk coverage from 8 a.m. to 8 p.m., Monday

through Friday. As part of the expanded coverage, the NCCS successfully transitioned to a dispatcher support model. These support changes freed up specialized resource people to address more difficult support issues while maintaining rapid response to the user community.

### AlphaServer Transition Support

The NCCS continues to accommodate researchers transitioning to the NCCS's HP/Compaq AlphaServer SC45. Gerhard Theurich, of the NCCS applications team and SGI, improved the speed of an MIT global circulation model ultraviolet code being run on the SC45. The code supports ocean modeling efforts by Benny Cheng of JPL. The tuning corrected memory and performance bottlenecks, resulting in a 60 percent improvement in speed over ARC's SGI Origin 3000, which was previously used for this work.

### NCCS Starts Discussion Group with Earth Scientists

The NCCS' discussion group, "Numerical Methods and Scientific Supercomputing," began this June as a venue to discuss physics and computational techniques used to solve Earth science questions. Scientists can learn how to more effectively use the NCCS' computational resources, while NCCS user support staff can gain deeper insight into the science being run on NCCS systems. The format includes a formal presentation followed by extensive discussion. Presentations, which will resume this Fall, have included:

- Wei-Kuo Tao of GSFC's Mesoscale Modeling and Dynamic Group, June 6, 2003. Topic: The relationship between cloud microphysics and precipitation.
- Lois Curfman McInnes, Argonne National Laboratory, a PI of the DOE Common Component Architecture (CCA), June 20, 2003. Topic: Benefits of using CCA in developing numerical libraries.

## Outreach

### MU-SPIN Success Story: CERSER

NASA Minority University-Space Interdisciplinary Network (MU-SPIN) partner Elizabeth City State University (ECSU), a Historically Black College and University (HBCU), recently celebrated the grand opening of its Center for Excellence in Remote Sensing Education and Research (CERSER) in Elizabeth City, North Carolina. CERSER, a collaboration for innovative ocean, coastal, and marine research, represents a major milestone for ECSU



**Grand opening of ECSU's CERSER. From the left: Charles Luther, President, IEEE-Geoscience and Remote Sensing Society (GRSS); Sonia Galloges, IEEE-GRSS Distinguished Lecturer, Naval Research Laboratory at Stennis Space Center; Linda Hayden, PI, CERSER; and James Harrington, MU-SPIN Program Manager, ESDCD. Image credit: Joal Hathaway, ADNET**

and MU-SPIN. "This is the kind of success story NASA wants from all of its programs," says ESDCD's James Harrington, MU-SPIN Program Manager. "It is a perfect example of MU-SPIN Return on Investment."

NASA established MU-SPIN in 1990 to help train the next generation of minority scientists and engineers by providing service to America's HBCUs and Other Minority Universities. ECSU first participated in a MU-SPIN User Conference in 1992 and was selected through a competitive NASA proposal process as one of seven Network Resources Training Sites in 1995.

Since its early involvement with MU-SPIN, ECSU has explored innovative ways to bring the excitement of NASA-related science to faculty and students at minority institutions. ECSU first worked with MU-SPIN on network and training projects. These included interconnecting local public schools to NASA's on-line educational resources and providing workshops to train faculty, with topics ranging from "Introduction to the World Wide Web" to "Using the Internet for Research and Advanced Networking Architecture."

At MU-SPIN's encouragement, ECSU began expanding its program and joined forces with the North Carolina Office of Coastal Management and the Office of Naval Research (ONR) to offer undergraduate and faculty research projects using NASA's Sea-viewing Wide Field-of-view Sensor

(SeaWiFS) phytoplankton and sea surface temperature data to study coastal marine life. Shortly after, ECSU added undergraduate student researcher projects in the Great Dismal Swamp and hands-on faculty training programs, including the Earth System Science Academy and Mathematics of the Great Dismal Swamp.

Last year ECSU acquired a SeaSpace TeraScan satellite ground station for processing, cataloging, distributing, and utilizing data from the SeaWiFS and the NOAA Advanced Very High Resolution Radiometer instruments. After staff and faculty received training in operating and maintaining the TeraScan system, ECSU launched CERSER.

CERSER is a joint effort by ECSU, NASA, NOAA, ONR, Pixoneer Geomatics Corporation, SeaSpace Corporation, and the Wakefield Office of NOAA's National Weather Service. CERSER offers ECSU and its partners new possibilities for expanding minority students' exposure to, and participation in, Earth science. Standing solidly on a history of innovation and partnerships, CERSER is poised to be a leader in training tomorrow's professionals in the ocean, marine, and atmospheric sciences.

*(This excerpt is from an ECSU article featured at the MU-SPIN Web site.)*

<http://muspin.gsfc.nasa.gov/news/2003/cerser/>

### **MU-SPIN Supports NAI Team**

NASA recently announced the 12 new teams joining the NASA Astrobiology Institute (NAI), a national and international research consortium that studies the origin, evolution, distribution, and future of life on Earth and in the Universe. The GSFC team, proposing research in the "Origin and Evolution of Organics in Planetary Systems," with PI Michael Mumma of GSFC's Laboratory for Extraterrestrial Physics, includes a MU-SPIN component. MU-SPIN participants from the Minority Institution Astrobiology Collaborative (MIAC) will be Education and Public Outreach partners. MIAC will conduct student and faculty research with GSFC teams and will strengthen curricula in undergraduate and kindergarten-through-12th-grade classrooms with astrobiology content. The MU-SPIN institutions involved include Tennessee State University, Bennett College, Benedict College, South Carolina State University, Hampton University, Houston Community College, Cheyney University, and North Carolina Central University.

<http://mu-spin.gsfc.nasa.gov>

### **Shaping Maryland's IT Educational Requirements**

To better meet employment needs in information technology (IT), the Maryland State Department of Education is preparing to update IT curricula at the kindergarten through community college levels across the State. Educators from Maryland schools and representatives from about 30 local companies, including Northrop-Grumman, IBM, Verizon, and Honeywell, have been meeting since 1999 to provide recommendations. Marilyn Mack of the ESDCD has been representing NASA as a regular invitee. Mack is the NASA lead for the Space Hope Program and chair of GSFC's Visiting Student Enrichment Program.

### **"Journeys" Video Magazine Approved for Educators**

The NASA Earth Science Enterprise Education Product Review approved the "Journeys through Earth and Space" video magazine and video resource guide for distribution to educators for Grades 9 through 12. "Journeys" follows three Computational Technologies (CT) Project Grand Challenge investigation teams seeking to understand why the Rocky Mountains are located so far inland, how to monitor the changing Amazon rain forest, and when the sun will fling coronal mass ejections towards Earth. Jarrett Cohen coordinated production of these resources, including working with GSFC's Education Office to recruit teachers who contributed background material and classroom activities. The video and guide are available through NASA's Central Operation of Resources for Educators (CORE) and 71 NASA Educator Resource Centers at NASA field centers, museums, colleges, and other nonprofit organizations across the U.S. "Journeys" materials are also available on the Web.

<http://ct.gsfc.nasa.gov/journeys>

<http://core.nasa.gov>

<http://spacelink.nasa.gov/ercn>

## **ESDCD Updates**

### **Grid Computing Project Connects to Gigabit Ethernet Network**

The High End Computer Network (HECN) Team, led by Patrick Gary, installed a Gigabit Ethernet (GE) switch that connects GSFC's Information Systems Center's Advanced Data Grid Prototype (ADGP) project to the Science and Engineering Network (SEN). During a test, the ADGP server throughput was measured at speeds of up to 663.5 Mbps on the 1-Gbps SEN, which was more than 10 times faster than a test measurement using GSFC's

100-Mbps Center Network Environment. The new networking speed will help the project as it evaluates the application of unused processing time from a grid of networked computers to complex Earth science computational tasks.

### **Invasive Species Forecasting System**

With annual economic costs to the U.S. of over \$137 billion, invasive species has become a top environmental issue of this century. NASA's OES and the U.S. Geological Survey (USGS) have been jointly developing a National Invasive Species Forecasting System (ISFS) for the early detection, remediation, management, and control of invasive species (see ESDCD News, Winter 2003). John Schnase, a senior scientist at the ESDCD, is PI for the ISFS.

To support further development of the invasive species application, a proposal by Schnase was awarded \$2.65 million in funding over 5 years under NASA's Earth Science Enterprise (ESE) CAN-01-OES-01. "The Invasive Species Data Service: Towards Operational Use of ESE Data in the USGS Invasive Species Decision Support System" was one of 41 proposals selected to join ESE's Research, Education, and Applications Solutions Network (REASoN). REASoN is a distributed network of data and information providers for ESE science, applications, and education. Schnase is PI for this work, with Co-Investigators James Smith of GSFC's Laboratory for Terrestrial Physics and Thomas Stohlgren of USGS's National Institute of Invasive Species Science.

Furthering the ISFS effort is a new ISFS Web site, created by Schnase's team at NASA and the USGS with funding from NASA's Earth Science Technology Office (ESTO)/CT. The site serves as a central repository for ISFS, and includes a major science section describing CT project-related work. The site also features ISFS test sites, partners, people, and news, as well as general information on invasive species.

The ISFS Web site will provide details about initiatives recently developed on the "Big Problem," a strategic plan for mapping the distribution of the tamarisk shrub in the upper Colorado River watershed and Canada thistle in Colorado. The "Big Problem" challenge will set the stage for the third year's work on ESTO/CT performance improvement milestones. These initiatives were developed at the ISFS's third science team meeting, which was held in Fort Collins, Colorado, on July 9–10, 2003. The meeting was hosted by the USGS Fort Collins Science Center's National Institute of Invasive Species Science.

ISFS Web site: <http://bp.gsfc.nasa.gov>

[http://research.hq.nasa.gov/code\\_y/nra/current/CAN-02-OES-01/winners.html](http://research.hq.nasa.gov/code_y/nra/current/CAN-02-OES-01/winners.html)

<http://esdcd-news.gsfc.nasa.gov/2003.Winter/02.invasive-species.html>

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